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(54) Method for manufacturing a semiconductor structure comprising regions formed with low dielectric constant material

(57) An interconnect structure having a dielectric layer with low dielectric constant is formed within an integrated circuit. In one embodiment of the invention, portions of a silicon dioxide layer (18) lying adjacent to a conductive interconnect (21) are removed to expose portions of a silicon nitride etch stop layer (16). A dielectric layer (22) having a low dielectric constant is then formed overlying the conductive interconnect (21) and the exposed portions of the silicon nitride etch stop layer (16). A portion of the dielectric layer (22) is then removed to expose the top surface of the conductive interconnect (21) to leave portions of the dielectric layer (22) between adjacent conductive interconnects (21). The resulting interconnect structure has reduced cross-talk between conductive interconnects (21) while avoiding prior art disadvantages of reduced thermal dissipation and increased mechanical stress.

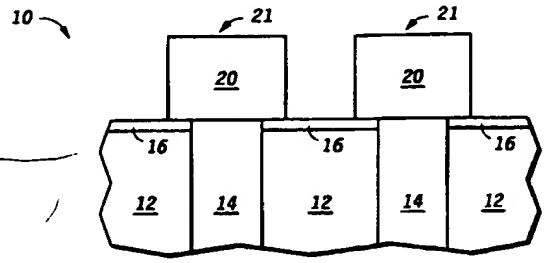

FIG.4

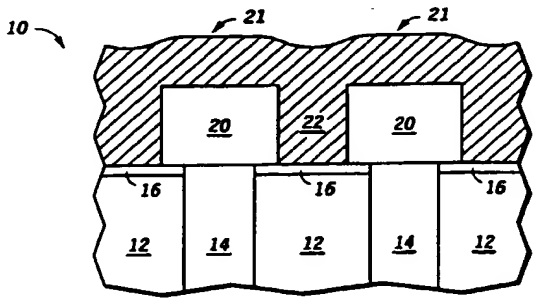

FIG.5

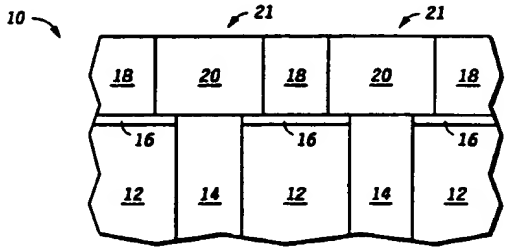

FIG.3

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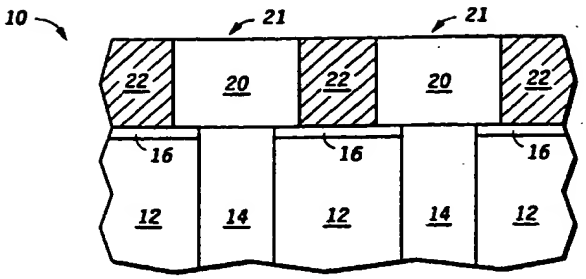

FIG.6

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EUROPEAN SEARCH REPORT

Application Number
EP 97 11 6851

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO 96 19830 A (ADVANCED MICRO DEVICES INC) 27 June 1996 * page 1, line 14 - line 26 * * page 2, line 11 - line 31 * * page 3, line 24 - page 5, line 19; figures 1-6 *	1-5	H01L21/768 H01L23/522 H01L23/532
X	US 5 510 293 A (NUMATA KEN) 23 April 1996 * column 1, line 21 - line 53 * * column 1, line 62 - line 67 * * column 2, line 3 - line 6 * * column 5, line 11 - line 55; figures 3A,3B,4A-4C * * column 5, line 66 - column 6, line 16; figures 6A-6D * * column 6, line 26 - line 37 *	1-3	
X	EP 0 701 277 A (TEXAS INSTRUMENTS INC) 13 March 1996 * column 2, line 42 - column 3, line 11 * * page 4, line 41 - page 5, line 8; figure 2 * * page 5, line 12 - line 27; figure 4 * * page 5, line 33 - line 41; figures 7,8 * * page 5, line 46 - line 56 *	1-3	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H01L
A		5	
X	EP 0 684 642 A (TEXAS INSTRUMENTS INC) 29 November 1995 * page 2, line 3 - line 22 * * page 2, line 55 - page 3, line 2 * * page 3, line 23 - line 25 * * page 6, line 32 - column 41, line 6A-6C * * page 8 *	1,3	
A		4	

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~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
BERLIN	5 May 1998	Klopfenstein, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EPO FORM 1503 03.82 (P04C01)

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EUROPEAN SEARCH REPORT

Application Number
EP 97 11 6851

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 706 215 A (TEXAS INSTRUMENTS INC) 10 April 1996 * column 1, line 5 - line 41 * * column 1, line 51 - column 2, line 4 * * column 3, line 46 - column 4, line 5; figure 1 * * column 4, line 41 - line 54; figure 3 * * column 5, line 38 - line 56; figures 7-9 * ---	1,3	
A		2,5	
A	US 5 559 055 A (CHANG MARK S ET AL) 24 September 1996 * column 1, line 8 - column 2, line 24 * * column 2, line 60 - line 67 * * column 3, line 1 - column 5, line 17; figures 1-4 * * column 5, line 28 - line 31; figure 5C * ---	1-5	
A	EP 0 703 611 A (TEXAS INSTRUMENTS INC) 27 March 1996 * page 2, line 5 - line 40 * * page 2, line 50 - line 54 * * page 4, line 48 - line 55; table 1 * * page 5, line 40 - line 54; figures 10-15 * ---	1-3	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	HOMMA Y ET AL: "LOW PERMITTIVITY ORGANIC DIELECTRICS FOR MULTILEVEL INTERCONNECTION IN HIGH SPEED ULSIS" INTERNATIONAL CONFERENCE ON SOLID STATE DEVICES AND MATERIALS, 21 August 1995, pages 154-156, XP000544585 * page 154, paragraph 2 - page 155, paragraph 3; figure 1B; table 1 * --- -/--	1-3	

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	WO 87 04858 A (PLESSEY OVERSEAS) * page 2, line 12 - page 3, line 14 * * page 4, line 22 - page 6, line 2; figures 1-4 * ---	6-8	
A	US 5 407 860 A (STOLTZ RICHARD A ET AL) 18 April 1995 * column 1, line 66 - column 2, line 28 * * column 2, line 65 - column 3, line 39; figures 1-6 * ---	6-8	
A	MINAMIHABA G ET AL: "DOUBLE-LEVEL CU INLAID INTERCONNECTS WITH SIMULTANEOUSLY FILLED VIA-PLUGS" INTERNATIONAL CONFERENCE ON SOLID STATE DEVICES AND MATERIALS, 21 August 1995, pages 97-99, XP000544574 * page 97, paragraph 2 - page 98, paragraph 4; figures 2,3 * -----	6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)

~~The present search report has been drawn up for all claims~~

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BERLIN	5 May 1998	Klopfenstein, P

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Application Number
EP 97 11 6851

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

SEE SHEET B
(in case of Lack of Unity)

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☒ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

1-8

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 97 11 6851

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-5

   A method for isolating a first and a second laterally separated conductive regions, by filling a gap between said two regions with a dielectric layer having a dielectric constant e lower than 3.5 (Figs.1-6).

2. Claims: 6-8

   A method for forming isolated separated conductive interconnects by etching interconnection trenches in portions of a second dielectric layer, said trenches also exposing air gaps formed in a previous step of patterning an underlying first dielectric layer and filling these trenches and air gaps by conductive material (Figs.7-10)

3. Claim : 9

   A method for isolating adjacent separated conductive members by forming, via a spin-on process, a dielectric layer overlying the separated conductive members, without filling the space separating said members, thus bridging said space to form an air gap (Figs.11-15)

4. Claim : 10

   A method for isolating adjacent separated conductive members by forming, via a PECVD process, a non-conformal dielectric layer overlying the separated conductive members, thus forming a sealed void between at least two of the conductive members, the sealed void spanning at least 50% of the distance between the two conductive members (Fig.16).